Perspectives on Human
Factors Research on Adaptive
Interface Technologies for
Automobiles

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Soesterberg, The Netherlands

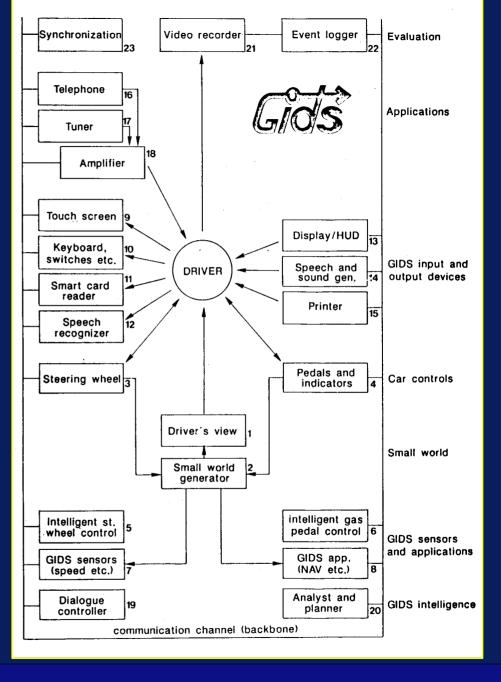


This guy needs us - to a certain degree



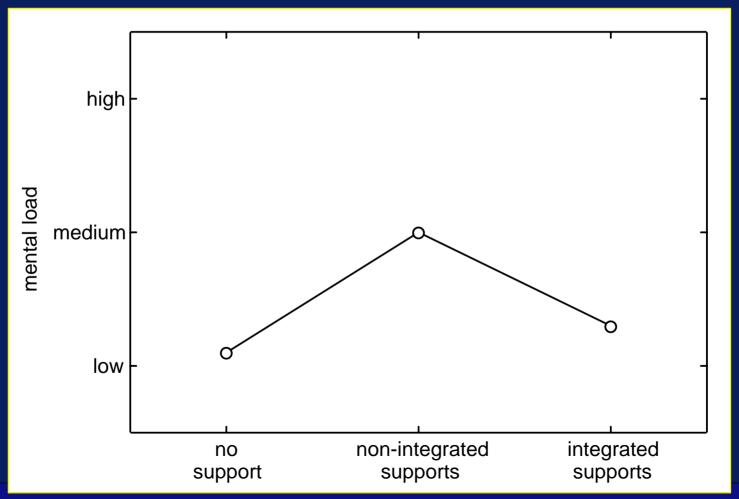


This is how we will help him (GIDS,1990)





The case for integration: Supports can *increase* workload!





Outstanding issues

- Assessing driver state
- Assessing the state of the world
- How good is driver adaptivity already?
- Driver responses to adaptive systems
- Methodologies for evaluating effects
- From driver state/behavior to accident risk
- User acceptance



Driver state

- Can we be in time?
- Can we predict?
- Physiology vs look-up tables/formulas (example: fatigue research)
- In tables should be: (a) infrastructure (b) traffic conditions (c) driver characteristics

Example: Pragmatic workload estimates / allowable workloads (Co-Drive)

Highway 0-30 km/hr <u>Low</u>

30-50 Medium

50-80 Medium

80-100 Low

100-120 Low

> 120 High

Roundabout 0-30
 Medium

30-40 High

> 40 High



Driver state

- How to detect and predict! sudden workload peaks?
- What is the relation between workload and distraction?



Sensitivity to peak loads (Kuiken et al, 1995)

- Steering activity parameters, of those that are realistically appicable, are possibly the most sensitive to index visual load
- Newest development: ratio of driver-induced vs roadinduced steering pattern



The detection of deteriorating driving performance

- Candidate parameters:
- Eyelid closure parameters
 Problems: (1) Validity for predicting drifting off?
 (2) Formidable measurement problems
- Steering activity
 No major technical problems
- Lane keeping performance
 No major technical problems



Driver underload

Mind your good old Yerkes-Dodson



New opportunities to make errors

Because of complexities of design and maintenance



Loss of skills

• Is it always bad?



Lack of 'situational awareness' - Mode errors

Example: Airbus accidents (fly-by-wire; 'arm wrestling' between pilot and machine)



Transitions in time and place

- Mix of equipped and non-equipped vehicles
- Mix of environments that are integrated to different degrees

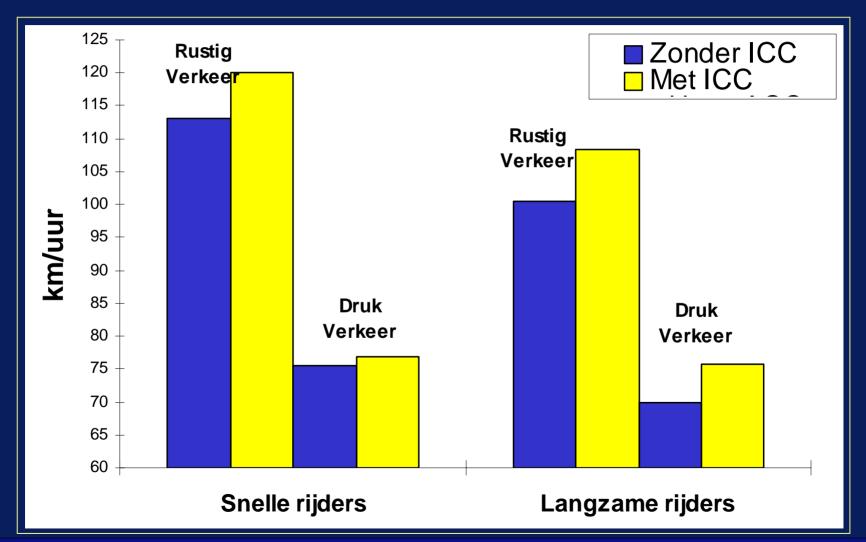


Direct behavioral adaptation

- Shown to occur for ICC, ABS, seat belts
- Nobody can tell whether it is total
- Gain may thus be in mobility rather than safety

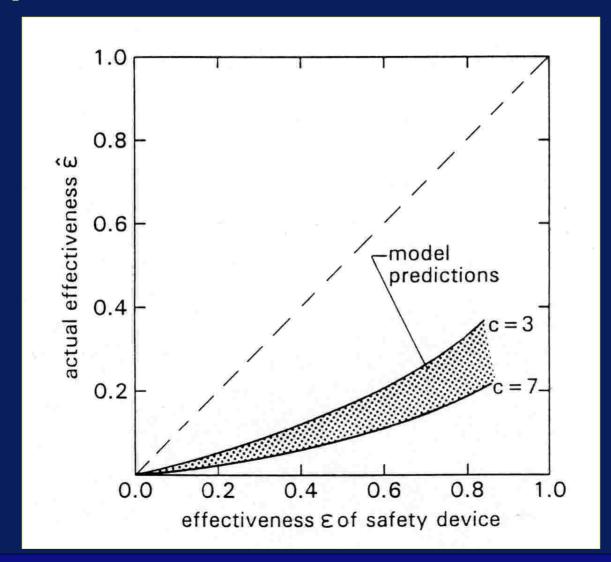


ICC brings about behavioral changes





Model of effect of behavioral adaptation on effective risk reduction





Higher-order forms of behavioral adaptation

- More bad drivers on the road
- Venturing into more risky situations
- Generating more mileage



Methodologies to evaluate effects

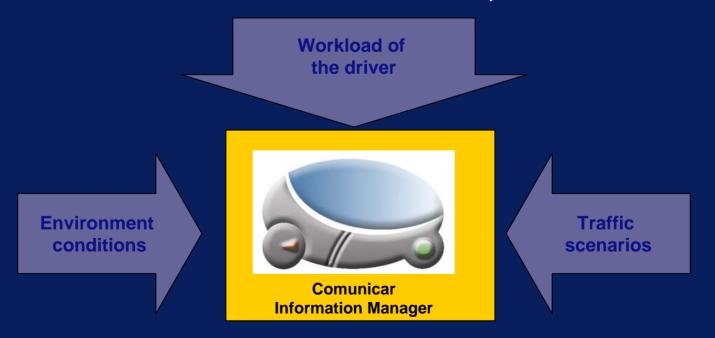
- Will they be different from those used for assessing single systems?
- Long-term evaluation is a must
- With particular attention to 'early indicators'



Example: COMUNICAR

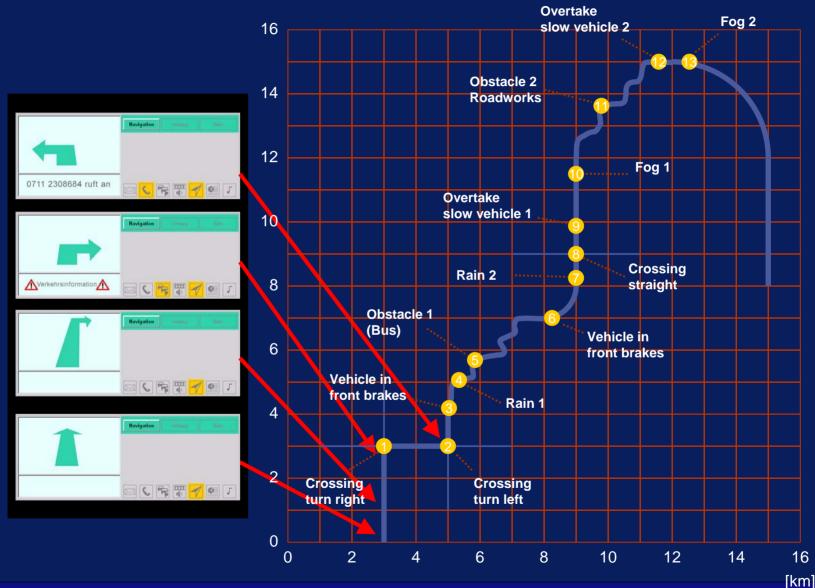
The **Information Manager** will manage the interactions between driver and car on the basis of:

- the environment;
- the traffic scenarios;
- the workload of the driver;





Route in simulator





14 scenarios

- Fog and receive navigation message or traffic information
- Rain and receive traffic information or phone call
- Roadworks obstacle and receive navigation message
- Overtake slow vehicle and phone call or navigation message
- Fog and receive traffic information or phone call
- Vehicle in front brakes and receive phone call or traffic information
- Rain and receive SMS
- Bus obstacle and receive phone call or traffic information
- Receive traffic information and phone call
- Vehicle in front brakes and receive traffic information or SMS
- Rain and receive navigation message
- Cross an intersection and receive traffic information or SMS
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Results

Event	Speed SDspeed		SDLP Steering		front car	LW	TOTAL positive	TOTAL negative
Fog + NS or TI							1	3
Fog + TI or MP							2	1
Roadworks obstacle + NS							2	2
Bus obstacle + MP or TI							3	3
Overtake slow vehicle 1 + MP							3	2
Overtake slow vehicle 2 + MP or NS							5	1
Vehicle in front brakes + MP or TI							3	3
Vehicle in front brakes + TI or SMS							5	0
Rain + TI or MP							1	4
Rain + SMS							2	1
Rain + NS							0	2
Crossing straigt + TI or SMS							2	1
TI + MP							2	1
TI + SMS							1	2
TOTAL positive	8	2	3	5	8	6	32	
TOTAL negative	2	4	5	6	3	5		25







Conclusions

Over all incidents, driving with IM leads to safer driving with less workload.

But this can be very different between scenarios (also see Piechulla et al., 2003).



From state/behavior to risk

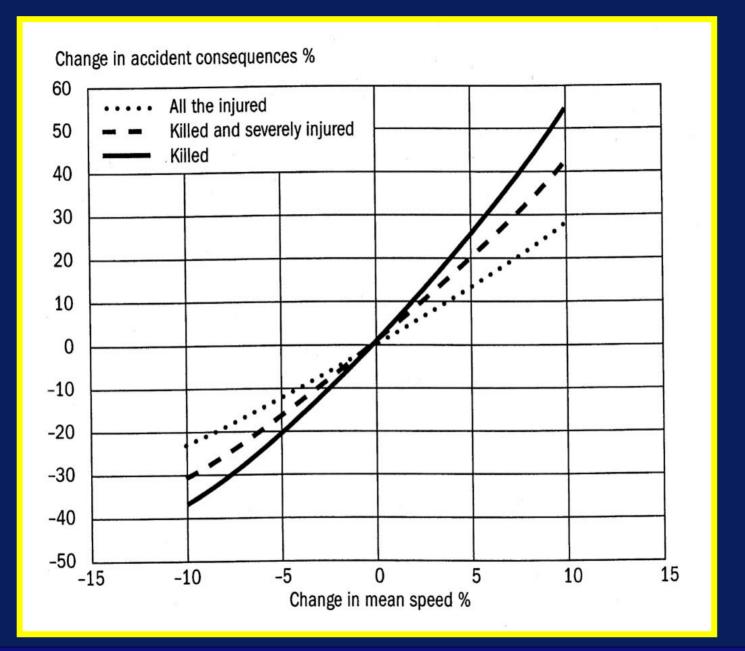
- Longitudinal
- Lateral
- Car-following
- Interactions
- Combined?
- Combined with driver state?
- Is micro-simulation the solution?



Speed and accident risk

Nilsson functions





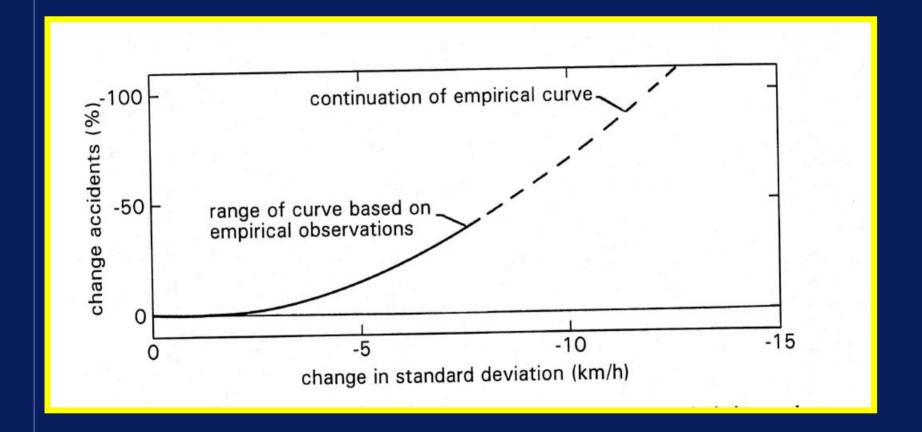


Speed variability and accident risk

Model Salusjärvi

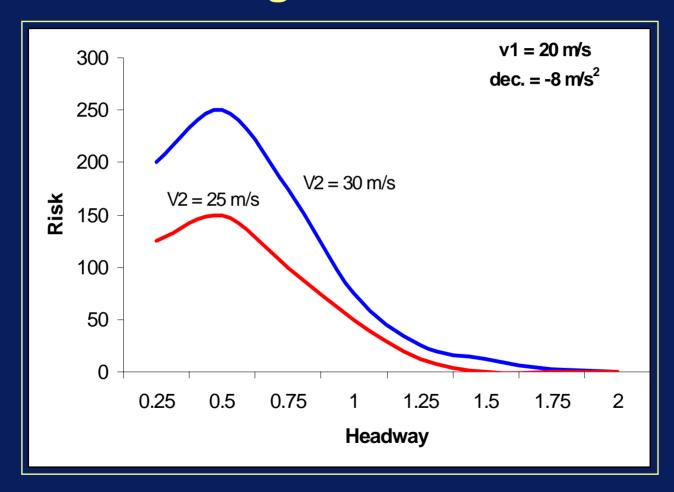
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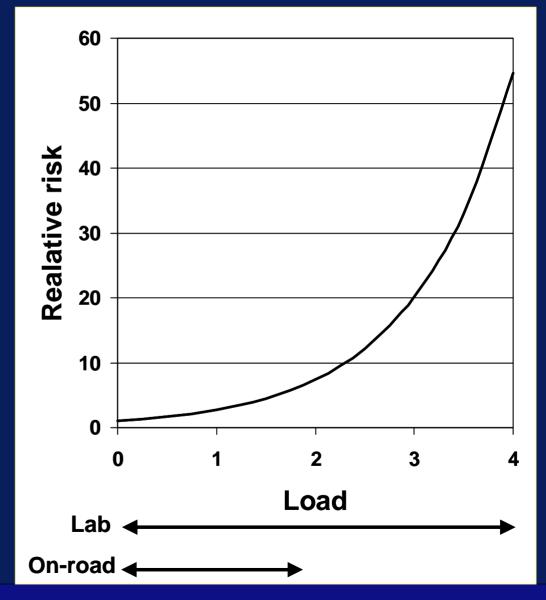


Car-following behavior and risk



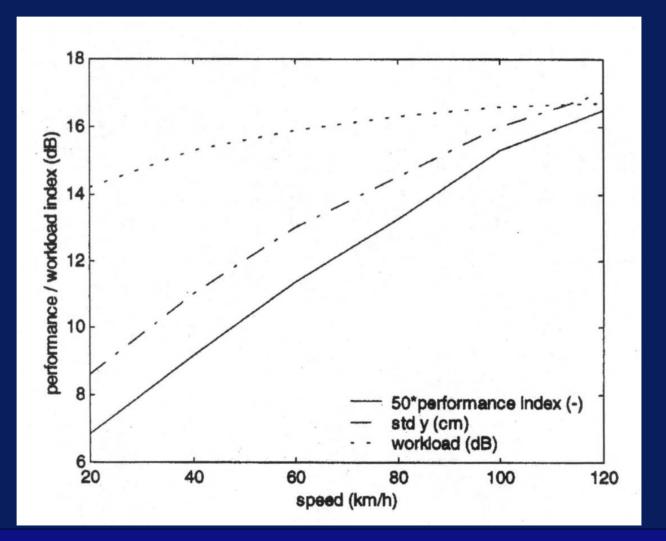


Sometimes we can calibrate

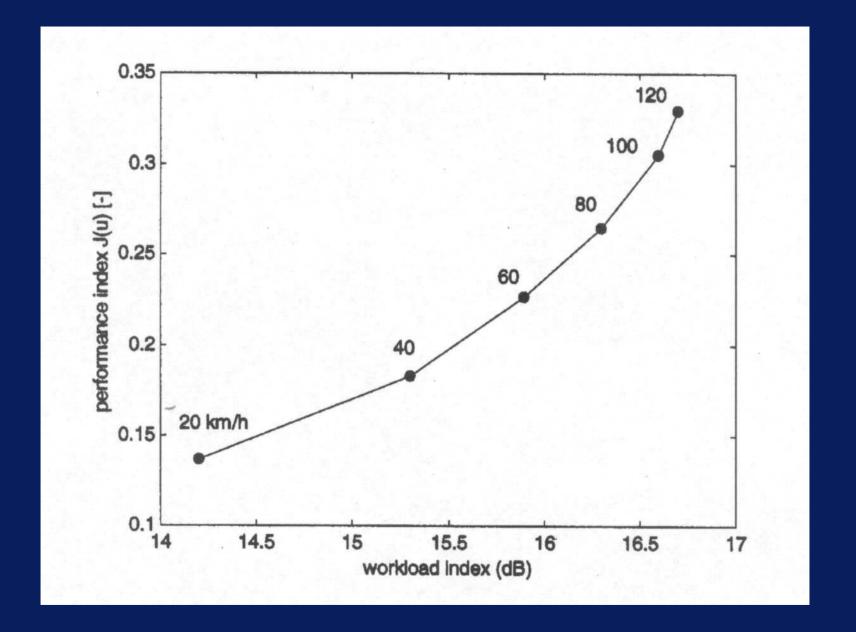




Modelling driver performance and workload: OCM (Wewerinke)









User acceptance

- Can and should be studied as part of evaluation experiments, e.g. by means of 2-dimensional van der Laan et al. scales
- Will a well-designed system always be an acceptable one?



Conclusions

- This is a very exciting area
- It can be a showcase for what human factors research can contribute to solve a major societal problem
- It is also an opportunity for human factors research in the traffic behavior area to develop itself to a higher level of maturity

Driver responses and how to anticipate on them



Consequences of in-vehicle supports

- Bad ergonomics
- Distraction
- Overload
- Underload
- Behavioral adaptation ('risk compensation)
- Mode errors / lack of situational awareness
- Loss of skills / unlearning
- Transitions in time and place
- Opportunities for new errors





520

12%



YQ

27%

SAFE



RTI

14%





C1

24%



Visual overload: Wierwille's formula

- Number of deaths in US = proportional to:
- (market penetration fraction) *
- [0.133+ [0.0447 * (mean glance time) exp 1.5 *
- (# of glances) *
- (frequency of use/week]]
- Mean glance time has more weight than number of glances: 2 x 4 is not equal to 4 x 2



Demand on visual displays (candidate concretization of European ESoP)

No more than 4 glances, each lasting no longer than 2 s



A way out? Unoccupied channels!

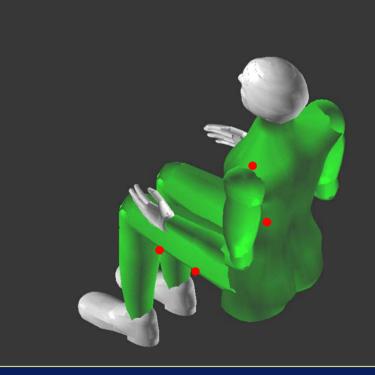
- Tactile/vibration (skin)
- Olfaction
- Multimodal



Lane keeping

Border Violation strength coded by secondary parameters

Navigation



No longer: "no, your other left"



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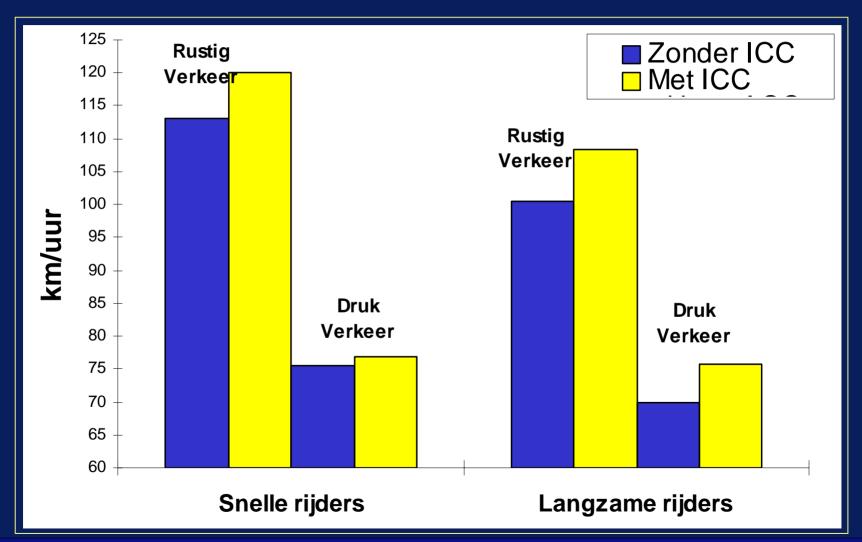


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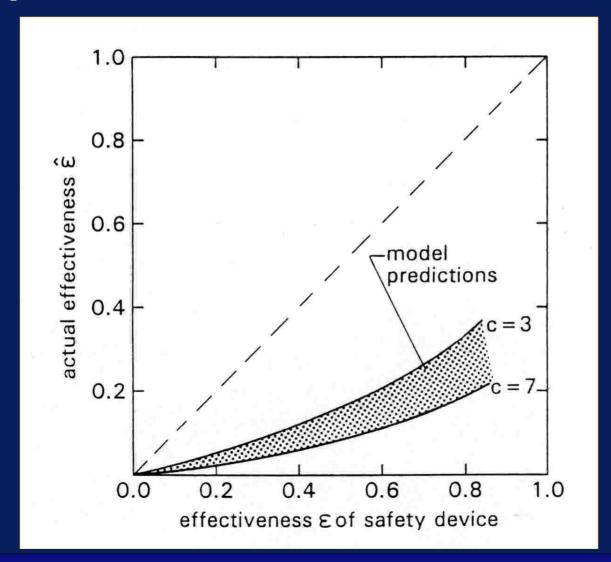


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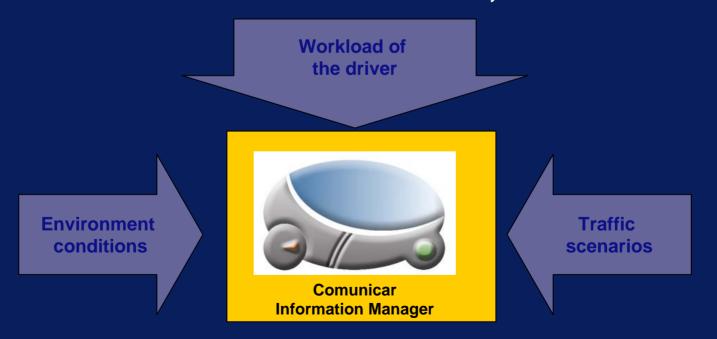
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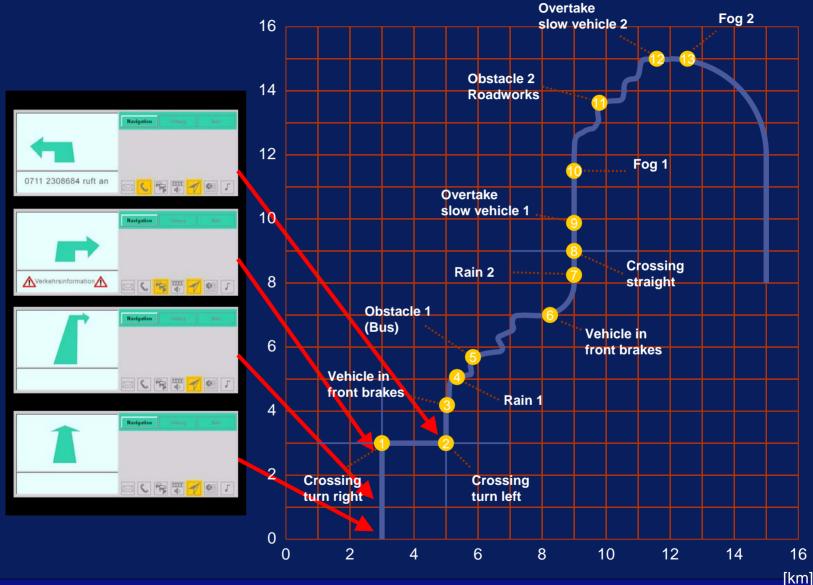
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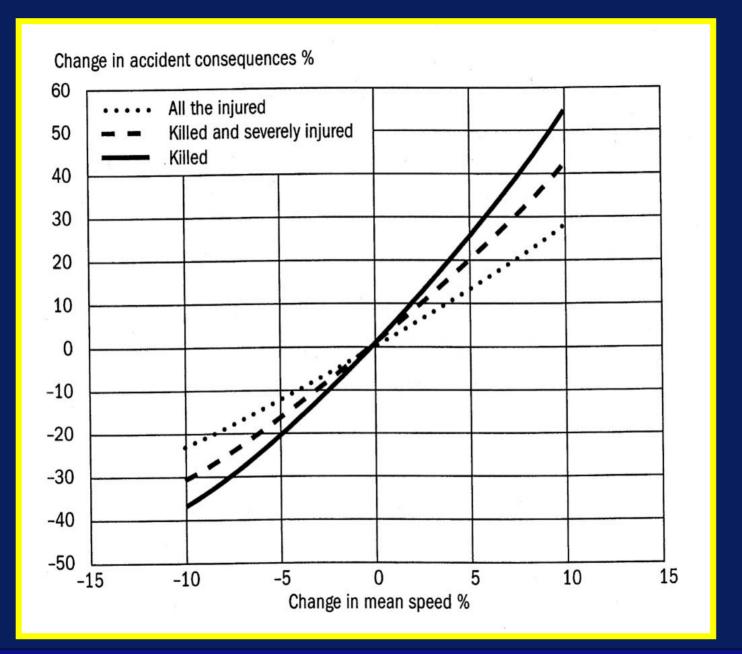
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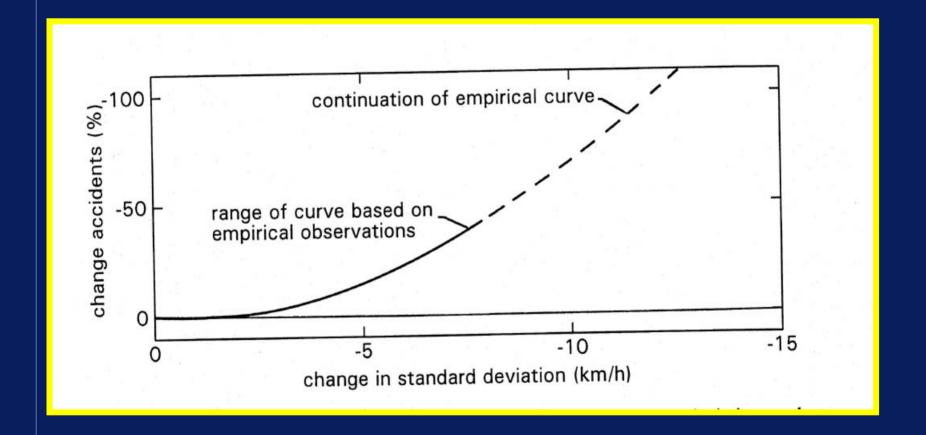


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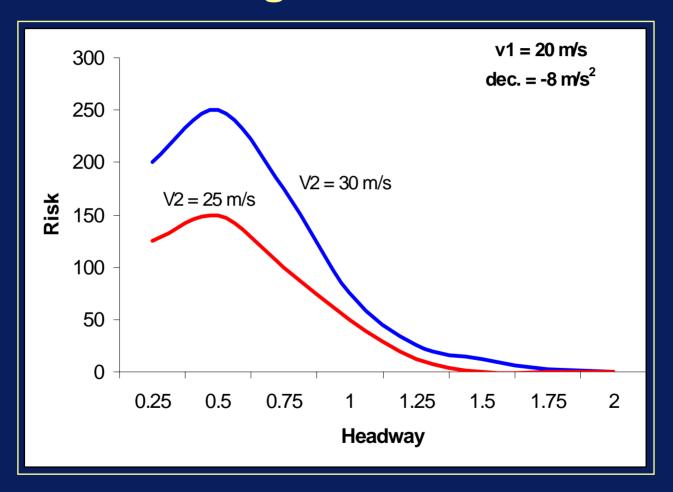
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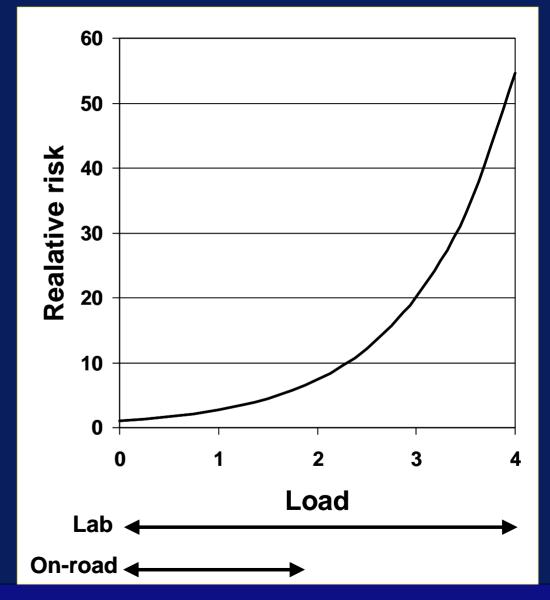


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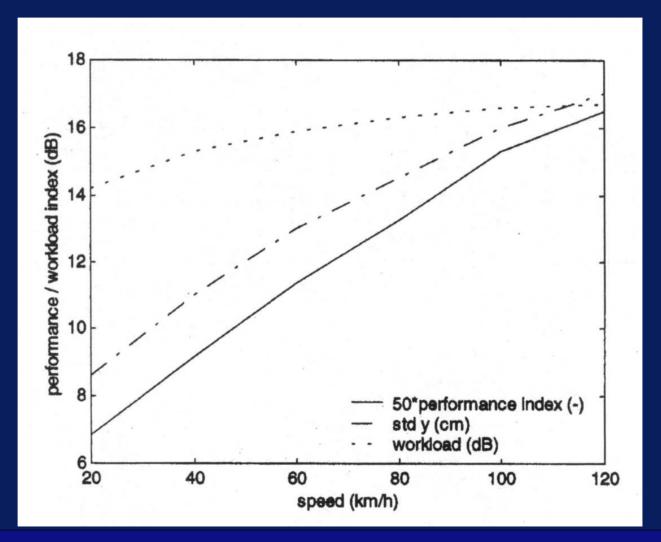


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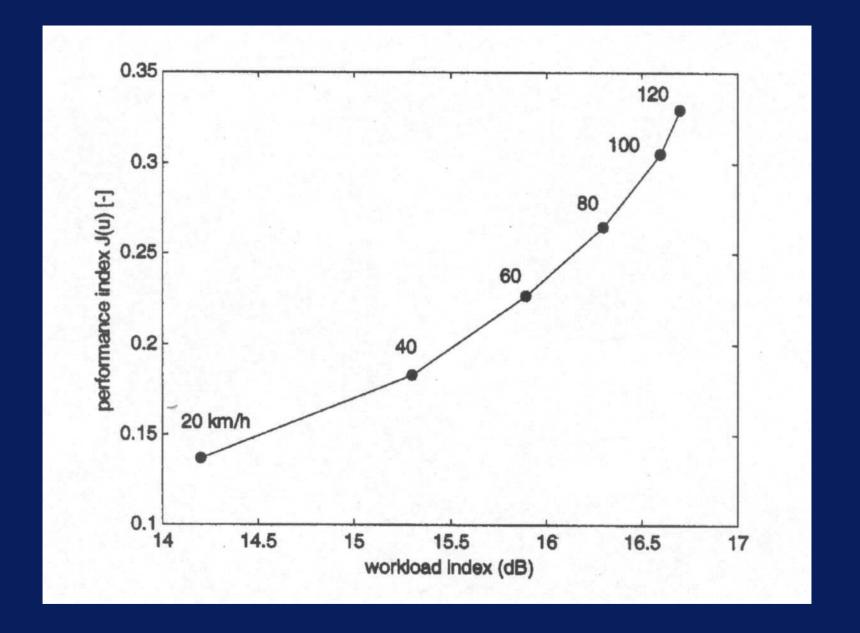




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